



# DWBB Datapath – Trigonometric Overview

The trigonometric IP, many of which can be inferred, are applicable to ASIC or SoC designs. These IP are high performance trigonometric implementations (based on a fast carry look-ahead architecture).

## Related Topics

For a listing of Building Block components and associated datasheets, see:

- [DesignWare Building Block IP Overview](#)

## Theory of Operation

DW\_sincos performs the sine or cosine of  $\pi$  times the input angle  $A$ . If the control signal  $SIN\_COS$  port is low, DW\_sincos calculates  $\sin(\pi A)$ . If  $SIN\_COS$  port is high, DW02\_sincos calculates  $\cos(\pi A)$ .

The input angle  $A$  is treated as a binary fixed point number which is a binary subdivision of the range  $0 \leq A < 2$  (unsigned) or the range  $-1 \leq A < 1$  (signed). It does not matter whether the input is signed or unsigned because the sine or cosine from  $-\pi$  to zero is the same as it is from  $\pi$  to  $2\pi$ .

The sine function can be converted to the cosine function because of the following:

$$\cos(\pi A) = \sin\left(\pi A - \frac{\pi}{2}\right) = \sin\left(\pi\left(A - \frac{1}{2}\right)\right)$$

Parameter  $A\_width$  is the width of input angle  $A$ . It can have a value of 2 to 34.

Therefore, if  $SIN\_COS = 0$ , then

$$A[A\_width-1:A\_width-2] = A[A\_width-1:A\_width-2] - 1$$

If  $A[A\_width-2] = 1$ , then  $A[A\_width-3:0] = -A[A\_width-3:0]$

Now, if  $A[A\_width-1] \text{ xor } A[A\_width-2] = 1$ , then set a change\_sign bit.

The problem has been reduced to a quarter-wave cosine function, where  $0 \leq A < 1/2$ .

If  $A\_width \leq 8$ , then the quarter-wave cosine function is directly decoded from  $A[A\_width-3:0]$ .

Else, if  $A\_width > 8$ , there are three cases as follows:

- $wave\_width \leq 16$   
Perform a linear interpolation of the quarter-wave cosine as 64 straight-line segments.
- $16 < wave\_width \leq 24$   
Perform a quadratic polynomial interpolation of the quarter-wave cosine as 64 second-order equation curve segments.
- $24 < wave\_width \leq 34$   
Perform a cubic polynomial interpolation of the quarter-wave cosine as 64 third-order equation curve segments.

Finally, if `change_sign` was set, the answer is negated.

## Related Topics

- [DesignWare Building Block IP User Guide](#)

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